



# Research Team Overview for USTAR Governing Authority

Presented by: USU USTAR Biofuels Team

**UtahStateUniversity**

# Rationale

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“The supply of secure, clean, sustainable energy is arguably the most important scientific and technical challenge facing humanity in the 21<sup>st</sup> century.”

Proceedings of the National Academy of Sciences (2006)

- Algae produces far more oil than other feedstocks.
- Algae production doesn't compete w/ food supplies.
- Utah has the resources for large scale deployment.

# Summary of Progress

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- USTAR hiring process complete
- Extramural awards exceed USTAR investment
- Extensive IP generated and protected
- World-class research facility operational
- Extensive partnerships formed
- Interdisciplinary activities span RD&D
- Scale-up farming activities planned for 2011
- Commercialization entity established

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# USTAR Biofuels Team

Research

Development

Commercialization



Byard Wood



Lance Seefeldt



Jeff Muhs



Kevin Shurtleff



Allen Shimizu



Ron Sims



Foster Agblevor—Final USTAR Hire

**Integrated team spanning research  
through commercialization**

**Total FTEs: 20**

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# USTAR Biofuels Program Focus

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## Goal:

- Develop algae farming technologies to produce affordable renewable liquid fuels and co-products.

## Multi-Year Objective:

- Develop self-sustaining biofuels research program.
- Create a technology base for a new industry in Utah.
- Spin-out technologies; production processes and create jobs.



# USU innovations / IP to date

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- **Disclosures filed: 20+; Applications filed: 5; Patents issued: 1**
- Discovery of high oil-producing algae strains from Great Salt Lake
- Environmental remediation processes
- Algal production and anaerobic digesters for rural UT dairy operations
- New cultivation and scale-up strategies
- New downstream processing techniques
- New business models and opportunities for Utah companies



**USU80 strain being grown in Uintah Basin produced water**

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# Return on Investment

- USTAR investments to date = \$4.5 million
- Extramural funding & awards = \$7.0 million

FUNDED / AWARDED PROJECTS	\$USU/\$Total
Arizona Public Service Company	\$106k
Bingham Research Center (BEERC)	\$75k
General Atomics - DARPA	\$500k/\$40MM
Logan City/Corella Engineering/UDEQ	\$400k +
Montana State University - DOE	\$150k/\$900k
Oak Ridge National Laboratory-DARPA	\$207k/\$750k
DOE – Office of Solar Energy Technologies	\$1.33M
DOE – Office of Biomass Programs (awarded; not yet under contract; expected release Nov. 2010)	\$4.35M



# State of the art USTAR-funded Facility

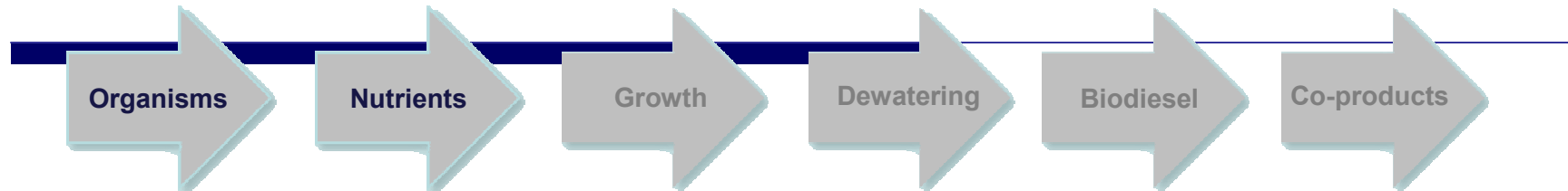


Kevin Shurtleff

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# Algal Biodiesel Project Flow



## USU80 GSL strain

DARPA Algae-to-JP8 Finalist

30+ strains  
high salt  
high pH  
high lipids

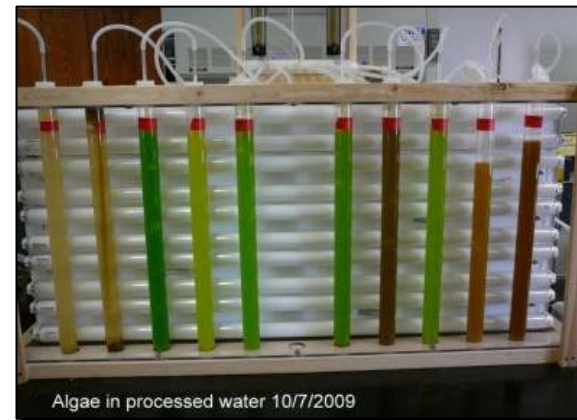


## GSL Collaboratory



Lance Seefeldt

## USU Algae in Produced Water



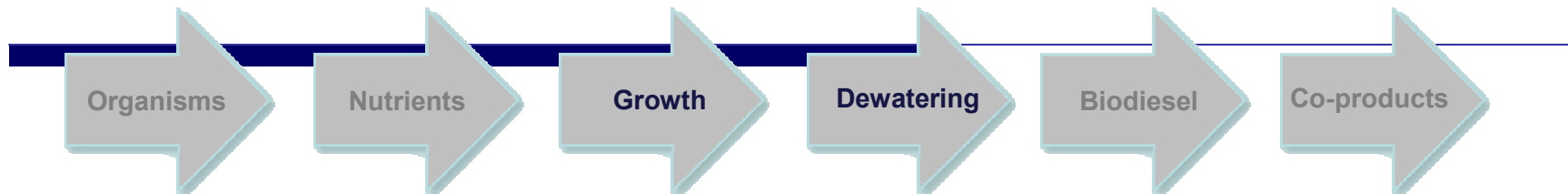
Achieved better growth in produced water than in lab media



## Uintah Basin

Simultaneous lipid production & water remediation demonstrated @ USU

# Algal Biodiesel Project Flow



**EDL will use power plant flue gas & existing ponds**



**Design extends growing season and eliminates excavation, raceways, paddle wheels, and thick liners; reduces labor, energy & other costs**



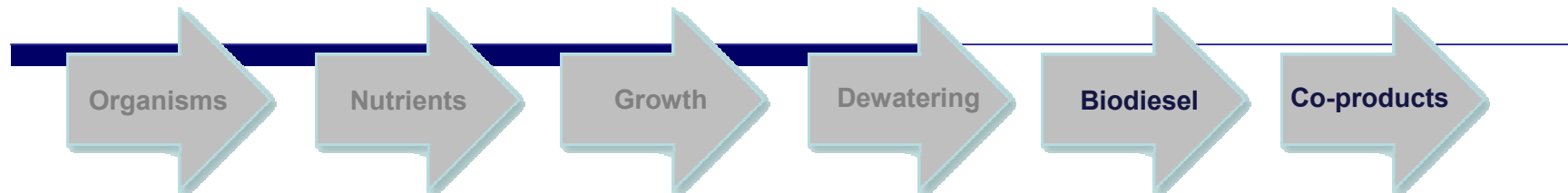
Kevin Shurtleff



Jeff Muhs

**10 acre facility planned in 2011**

# Algal Biodiesel Project Flow



## USU 1 Step Conversion Process



Lance Seefeldt

**Working with  
U of U on by-  
product to bio-  
oil conversion**

Negotiating with detergent & by-product OEMs

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# Example Collaboration

## Mountain/Southwest Algae to Fuel Enterprise MSAFE Proposal (\$45 Million); response to USDA RFP

Research, education & extension program to design a sustainable bioenergy co-op farm system to produce sufficient algae to operate a refinery that produces 40 million gallons per year of liquid fuels.

- MSAFE Team, led by USU, includes 8 Universities, National Lab, Logan City, and 4 industry partners; leverages \$50 million in algal research last 5 years;
- Region has abundant low temperature geothermal heat for year around operations and large tracts of low value land;
- Adequate saline/brackish water and CO<sub>2</sub> sources;
- Excellent solar energy resources.



Byard Wood

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# Success Story

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## Biogas from Dairy Cow Manure: Sunderland Dairy Digester System



- **Original Plan was to build an experimental IBR digester facility at a cost of \$1.5 Million.**
- Sunderland Dairy, Ephraim, UT
  - USU, USTAR, USDA, Dairy redesigned, repaired, and upgraded system;
  - 2 USU IBR and 2 vertical tank digesters operating side-by-side;
  - 42 KW connected to utility grid.
- No USTAR funds were used for capital improvements

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## Sunderland Dairy (cont.)

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- Annual IBR biogas production 34% greater than competing technology for conditions tested, experiments will continue through next year;
- Used Ferric Chloride as low cost H<sub>2</sub>S control;
- Heat recovery on digester effluent;
- Results will be directly applicable to marketing USU's IBR technology;
- Lab tests have shown that digester effluent is good source of nutrients for growing algae;
- This was a win/win for
  - USTAR    USDA    USU    Sunderland Dairy



# Logan Wastewater Treatment & Biofuel Production Project

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- Wastewater treatment plants
  - natural algae growth
  - release nutrients (phosphorous and nitrogen)
- Solution: Biofuel production w/ wastewater treatment
  - phosphorous removed by enhancing algal growth
  - algae harvested before discharge to Cutler Reservoir
  - algae processed in IBR to produce biogas



Ron Sims



# Sustainable Waste-to-Bioproducts Engineering Center



- Collaboration: USU and Logan City (Environmental Dept.)
  - Logan Wastewater Treatment Lagoons
  - Logan City Sanitary Landfill (Solid Wastes)
  - USU Research Laboratories
- Bio-products
  - Biodiesel
  - Biogas
  - Bioplastics (aka petro plastics)
  - Fertilizer & Soil Conditioner
  - Antioxidants from Algae



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# Commercialization



- Algal Energy Technologies Group: formed Sept10 as dba of Foundation Development Corp. (USURF)
- Three focus areas: Services, Oil Production, Wastewater Remediation
- Planned Spin-out: Sep11



**Allen Shimizu**

# Deliverables for FY11

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- 90 lbs of algal biomass – **complete**
- 10L of algal oil
- Demonstrate floating pond cultivation and cold weather growth
- Validate pH control with flue gas addition
- Validate new techniques for algae harvesting/extraction
- Foster Agblevor (Final USTAR Hire) start-up activities
- Three or more new contracts/agreements; Opportunities include:
  - USDA MSAFE proposal, Deseret Generation & Transmission (DGT) 10 acre facility, General Atomics Phase II, Sun Products (detergents); Hydromentia (waste water treatment), additional work with Logan City through new partnership



# USTAR Budget FY11 and beyond



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<b><u>Budget</u></b>	<b><u>2011</u></b>	<b><u>2012</u></b>	<b><u>2013</u></b>	<b><u>2014</u></b>
Personnel	578,000	600,000	356,200	239,026
Travel	55,000	55,000	81,786	85,439
Other Capital Assets				
Equipment	119,800	105,000		
<b><u>Total</u></b>	<b>752,800</b>	<b>760,000</b>	<b>537,986</b>	<b>324,455</b>

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# Past Budget



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<b><u>Budget</u></b>	<b><u>2007</u></b>	<b><u>2008</u></b>	<b><u>2009</u></b>	<b><u>2010</u></b>
Personnel	174,423	684,301	624,966	491,884
Travel	11,641	79,843	26,192	20,511
Equipment	75,058	171,982	103,987	741,654
<b><u>Total</u></b>	<b>348,686</b>	<b>1,278,942</b>	<b>1,004,129</b>	<b>1,588,036</b>

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